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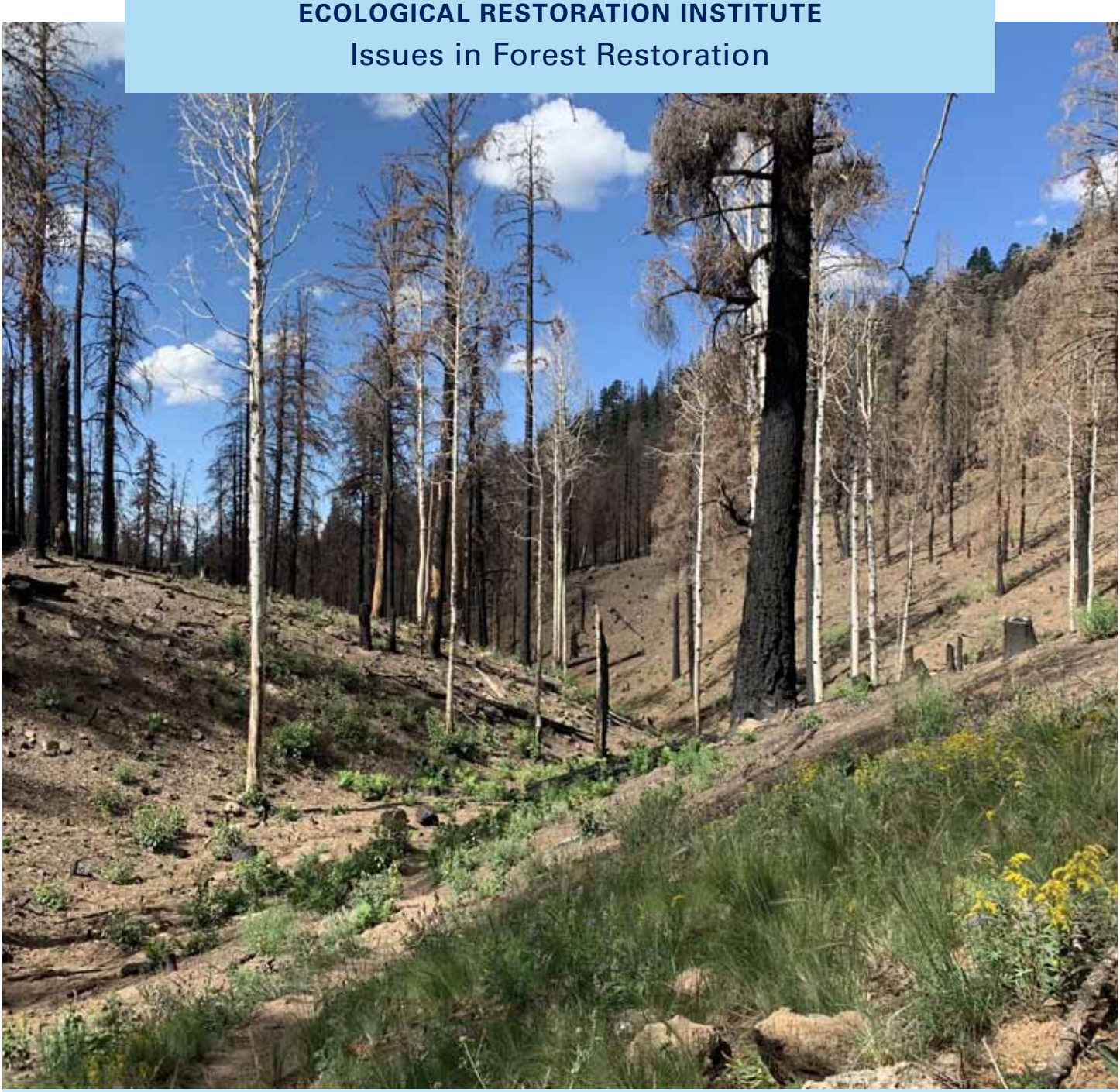

Local Experiences with the 2019 Museum Fire and Associated Flood Risk: A Survey of Flagstaff-Area Residents

November 2020

NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute

The Ecological Restoration Institute

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of dry, frequent-fire forests in the Intermountain West. These forests have been significantly altered during the last century, with decreased ecological and recreational values, near-elimination of natural low-intensity fire regimes, and greatly increased risk of large-scale fires. The ERI is working with public agencies and other partners to restore these forests to a more ecologically healthy condition and trajectory—in the process helping to significantly reduce the threat of catastrophic wildfire and its effects on human, animal, and plant communities.

Cover photo: View of a portion of the Museum Fire burn area. The fire burned 1,961 acres in the Dry Lake Hills north of Flagstaff in summer 2019. It burned in an area with steep slopes that feed into the Rio de Flag watershed. *Photo by Catrin Edgeley*

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Executive Summary

Communities across the western United States are growing increasingly familiar with the impacts of uncharacteristic wildfires and subsequent post-wildfire flooding. Recent notable fire and flood risk events in the Flagstaff, Arizona area offer a unique opportunity to understand how residents in affected communities experience these interconnected hazards and how it might influence future support for forest management. This white paper summarizes the results of a survey that collected data on resident experiences with the 2019 Museum Fire in Flagstaff, Arizona, to better understand the social impacts of wildfire and post-fire flooding, including experiences during the fire, communication about the fire and post-fire flood risks, experience with and understanding of the *Ready, Set, Go* (*RSG*) evacuation system, and perceptions of forest management in the Flagstaff area, FWPP, and the Museum Fire cause. Recent fire events and risk mitigation efforts in northern Arizona demonstrate that there is a critical need for social data that can influence emergency management, risk communication, and policy design and implementation. We found that respondents largely agreed that communication about the Museum Fire and subsequent fire risk was clear. However, many respondents indicated that the *RSG* evacuation system was confusing, and many respondents said that they expected to be notified to evacuate by a professional in-person. Overall, survey respondents demonstrated a high level of understanding regarding fire ecology, acceptance of forest management activities, and willingness to pay for future forest restoration and flood risk reduction projects. We developed a set of management and policy implications based on these results on the following topics: 1) communication during fire; 2) *Ready, Set, Go*; 3) post-fire flood risk; and 4) forest and fire management. These results and associated management and policy implications provide evidence-based, actionable information for wildfire incident management teams, emergency managers, and city and county officials related to fire and post-fire flooding risk in communities-at-risk for wildfire.

Introduction

Communities across the western United States are growing increasingly familiar with the impacts of uncharacteristic wildfires. The increase in severe wildfire events is largely due to past land management practices of fire suppression and exclusion coupled with insect and disease outbreaks, drought, and climate change. A long-lasting effect of severe wildfire, particularly in the Southwest where seasonal monsoons overlap with fire season, is subsequent post-wildfire flooding. These post-fire flooding events are expected to occur more frequently in the future due to increased wildfire and more extreme precipitation events due to climate change (Brunkal 2015). Recent notable fire and flood risk events in the Flagstaff area offer a unique opportunity to understand how residents in affected communities experience these interconnected hazards and how it might influence future support for forest management.

Post-fire flooding can have significant impacts, both ecologically and socially, extending many miles from the fire footprints where the floods originate. Steep slopes that burn at high severity during wildfire are especially susceptible to flooding after heavy rain events and can generate destructive flooding events (Neary and Leonard 2019). Resultant ecological impacts are spatially variable but can include soil erosion (DeBano et al. 2005), debris flows generated by water runoff (Carroll 2011, Rengers et al. 2016), soils that become altered and repel water and increase runoff (Koestner et al. 2011), and changes in stream chemistry (Murphy et al. 2018).

Several studies have documented the costs of post-fire flooding (Combrink et al. 2013) and estimated the potential costs of post-fire flooding (Arizona Rural Policy Institute 2014). Less is known about the social impacts of post-fire flooding, including how communities and local jurisdictions respond and adapt to post-fire flood risk (Mockrin et al. 2018). Predicting and planning for infrequent but high-impact events like extreme post-fire flooding, especially in places like the Southwest where monsoon rains are highly variable (Koestner et al. 2011), can be difficult to justify to stakeholders without a clear picture of both ecological and social impacts. There is a growing consensus that zoning regulations and adequate infrastructure developed through appropriate pre-fire planning can reduce potential damages and costs from post-fire flooding (Neary and Leonard 2019). However, communication around related mitigation actions is complex; some studies indicate that post-fire flood mitigation implemented in response to perceived flood risks may not always be effective (Chin et al. 2016).

This white paper summarizes the results of a survey that collected data on resident experiences with the 2019 Museum Fire in Flagstaff, Arizona, to better understand the social impacts of wildfire and post-fire flooding. Recent fire events and risk mitigation efforts in northern Arizona demonstrate a critical need for social data that can influence emergency management, risk communication, and policy design and implementation.

Wildfire and Post-Wildfire Flood Events in Flagstaff, Arizona

The Schultz Fire and the Flagstaff Watershed Protection Project

Flagstaff, located in Coconino County in northern Arizona, provides a unique opportunity to better understand the social impacts of both wildfire response and post-fire flood risk. The Schultz Fire burned over 15,000 acres of the Coconino National Forest north of Flagstaff in June 2010. Of those 15,000 acres, approximately 70% were classified as high to moderate burn severity (Koestner et al. 2011). When the monsoon rains arrived a few weeks later, heavy floods originating from the burned slopes flowed into downstream neighborhoods, resulting in significant infrastructure and housing damage, changes to the watershed, and one death. Flooding continues to be a significant issue for downslope neighborhoods in the years following the Schultz Fire, demonstrating the potentially long-lasting and widespread effects of fire and flooding to Flagstaff (Flagstaff Watershed Protection Project 2012). In 2013, the total economic impact of the fire and post-fire flooding was conservatively estimated to be between $133 million and $147 million, with projected future mitigation costs also in the millions (Combrink et al. 2013). Economic costs associated with post-fire flooding and mitigation were 10 times greater than the costs of fire suppression (Neary and Jackson 2019).

Following the Schultz Fire, the community of Flagstaff galvanized in recognition of the urgent need to: 1) reduce the risk of uncharacteristic wildfire and post-fire flooding; and 2) restore forest structure and function in areas that serve as critical foundations for the city's watershed. Existing efforts to restore ecosystem structure and function to the forested landscapes around Flagstaff by land management agencies like the Forest Service, stakeholder groups like the Greater Flagstaff Forests Partnership (GFFP), and landscape-scale collaborative groups like the Four Forest Restoration Initiative (4FRI) largely avoid areas with steeper slopes that are difficult to access and thus more expensive to treat. However, growing recognition that moderate to severe wildfire events that occur on steep slopes such as the Schultz Fire could have significant watershed impacts presented a shared motive for action in more challenging topography. Members of local land management agencies and the local community came together to coordinate efforts and provide funding for forest restoration work, with a focus on reducing the dense fuel loads in two key areas: the Dry Lake Hills north of Flagstaff, which feed into the Rio de Flag watershed, and Mormon Mountain south of Flagstaff, which feeds into Lake Mary — the main reservoir for the city.

Public support was paramount to sustain momentum for reducing severe wildfire risk to forests and watersheds. In November 2012, 73.6% of voters in Flagstaff approved a ballot measure known as the "Forest Health and Water Supply Protection Project," which approved a $10 million bond to fund the necessary fuel reduction work on these key watersheds (Flagstaff Watershed Protection Project 2012). This effort became known as the Flagstaff Watershed Protection Project (FWPP), the objective of which was to "reduce the risk of unnatural, high-severity wildfire on roughly 11,000 acres and the associated risk of post-fire flooding by utilizing a variety of treatment options on steep slopes, potentially including cable and helicopter logging methods" (Flagstaff Watershed Protection Project 2012). Strong partnerships with a range of organizations would be necessary to implement the FWPP, and a number of collaborators and funding partners were brought into the collaborative effort (Mottek-Lucas 2015). Local government also responded in creative ways. For example, Coconino County hired a forest restoration director in 2018 and invested taxpayer dollars through the Flood Control District to fund annual restoration work.

The Arizona Rural Policy Institute conducted a cost-avoidance study for the City of Flagstaff's FWPP Monitoring Team in response to the economic impacts associated with the Schultz Fire to better understand the potential costs that could be avoided by implementing the FWPP (Arizona Rural Policy Institute 2014). The estimated potential damage associated with

wildfire and flooding ranged between $489 and $986 million for the Dry Lake Hills and between $84 and $215 million for Mormon Mountain in 2014 dollars (Arizona Rural Policy Institute 2014). Meanwhile, a report titled, "Coconino County Post-Wildfire Debris Flow and Flooding Assessment" (Loverich et al. 2017) provided an evaluation of all the areas at risk for flooding and debris flow following wildfire in Coconino County. The report authors estimated that there is an increased risk to buildings and critical facilities throughout the county from wildfire and post-fire flooding, but that forest restoration and fuels reduction treatments could mitigate up to 58% of the risk when conducted within entire watersheds, including wilderness areas (Loverich et al. 2017). These studies further justified the importance of mitigating post-fire flooding risks in the Flagstaff area and throughout Coconino County.

Implementation of the FWPP first focused on the Dry Lake Hills area north of Flagstaff. The first phase of the FWPP included mechanical and hand thinning at the base of Mt. Elden in the Dry Lake Hills, concluding in 2018. The second phase of the FWPP included a combination of hand thinning, helicopter logging, and steep slope cutting, which were in various phases of completion in July 2019.

The Museum Fire

The Museum Fire started on July 21, 2019, in the Dry Lake Hills area that was currently undergoing fuels reduction as part of the FWPP. Approximately 1,961 acres were burned in the Dry Lake Hills, adjacent to the Schultz Fire burn scar. The fire significantly impacted ongoing FWPP implementation work, burning two log decks that were being offered for sale by the Forest Service and awaiting removal. However, because the focus of FWPP was the removal of small trees, these log decks were of little to no monetary value (Summerfelt 2019). The Museum Fire burned through a popular recreation area that recently had been opened up to the public following extended closures to assure safety during FWPP helicopter logging work. The fire and ensuing suppression efforts occurred in popular local recreation areas and abutted neighborhoods close to Flagstaff city limits, garnering great concern from the public (Figure 1). The fire was not contained until August 12, 2019 and resulted in a mixture of burn severities from low to high intensity (Coconino National Forest 2019).

Several neighborhoods near the Dry Lake Hills received evacuation orders, including an area impacted by the Schultz Fire and post-fire flooding events. Coconino County and other officials used the *Ready, Set, Go* (RSG) system to notify Flagstaff residents about evacuation orders during the Museum Fire. RSG is a system meant to educate property and homeowners of their wildfire risk and provide information about the actions that residents need to take in event of a wildfire. In addition to using the RSG system, officials also used a number of other outreach methods to communicate with the public, including in-person community meetings that were simultaneously live-streamed on social media.

The Museum Fire started on July 21, 2019 in the Dry Lake Hills area north of Flagstaff. The fire burned approximately 1,961 acres and was contained on August 12, 2019. *Photo by Melanie Colavito*

The Museum Fire started during a period that is typically the height of the monsoon season in northern Arizona. However, at the time, 2019 turned out to be the lowest monsoon season on record in Flagstaff in terms of precipitation totals, though it later became the second lowest after 2020 (NWS 2020). Concerns about post-fire flooding from the Museum Fire burn scar

were high, and while the fire was still actively burning, a thunderstorm dropped nearly two inches of rain in the Dry Lake Hills. City and county officials mapped out the areas of highest post-flood risk and communicated these risks to the public via numerous community meetings. Immediate efforts were made to provide jersey barriers and sandbags for the areas of highest risk, and many residents came together to fill and place sandbags for their neighbors. Neighborhoods in the projected flood zone were also placed on pre-evacuation notice. When additional rain and post-fire flooding never materialized, the community was left with mitigation measures in place that had not yet been fully utilized (Buffon 2019a).

A view of a steep slope burned by the Museum Fire. *Photo by Melanie Colavito*

The Museum Fire was classified as a human-caused fire, but the source of the ignition was under investigation for some time following full containment of the fire in early August 2019. Following the investigation, officials determined that the fire "was likely caused by an excavator striking a rock during operations" (Coconino National Forest 2019). The excavator was reported to have created a spark that hibernated overnight until temperatures and wind allowed it to grow into a fire the next day, which was July 21. However, no negligence on the part of the excavator operator was reported, as the operator had waited the customary amount of time to watch for a fire following the use of the equipment. The ongoing fuel reduction work as part of the FWPP was still emphasized as important for protecting the watershed following the fire (Buffon 2019b).

There is still much to be learned, both ecologically and socially, about the impacts and outcomes of the Museum Fire. This event provides a unique opportunity to better understand community perceptions of wildfire and post-wildfire flooding risk, especially in a community like Flagstaff that is accustomed to wildfire and post-fire flooding and generally supportive of efforts to reduce wildfire risk and restore forest health, as documented through initiatives like FWPP. At the same time, some of the details of the fire investigation have not been made public, and the timing of the fire during the middle of FWPP implementation was described by some as a "worst-case scenario." Therefore, we conducted a survey with Flagstaff residents to better understand their experiences with the Museum Fire, including experiences during the fire, communication about fire and post-fire flood risks, experience with and understanding of the *RSG* evacuation system, perceptions of forest management in the Flagstaff area, FWPP, and the Museum Fire cause.

Survey Approach

Surveys are a useful tool for rapid data collection at the household level in order to understand resident experiences and social impacts. We administered a mixed-mode survey during November and December 2019. Survey packets were mailed to 2,758 homes, which included a paper copy of the survey booklet, an introductory letter with information on how to take the survey online if preferred, and a postage-paid reply envelope. A reminder postcard was sent two weeks later. Survey materials were made available in both English and Spanish (although we received no responses via the Spanish format). Households selected to receive the survey included: (1) all homes placed under some form of wildfire evacuation warning during the Museum Fire; (2) all homes that had a projected risk of flooding up to three inches in depth after the Museum Fire based on modeling used by Coconino County; and (3) a random sample of households within the Flagstaff city limits that did not fall under the first two categories (Figure 1). We received 617 completed surveys from households identified through the mail survey sample for a response rate of 22.37%, which is in line with response rates for similar surveys and study populations. An online version of the survey was also shared via

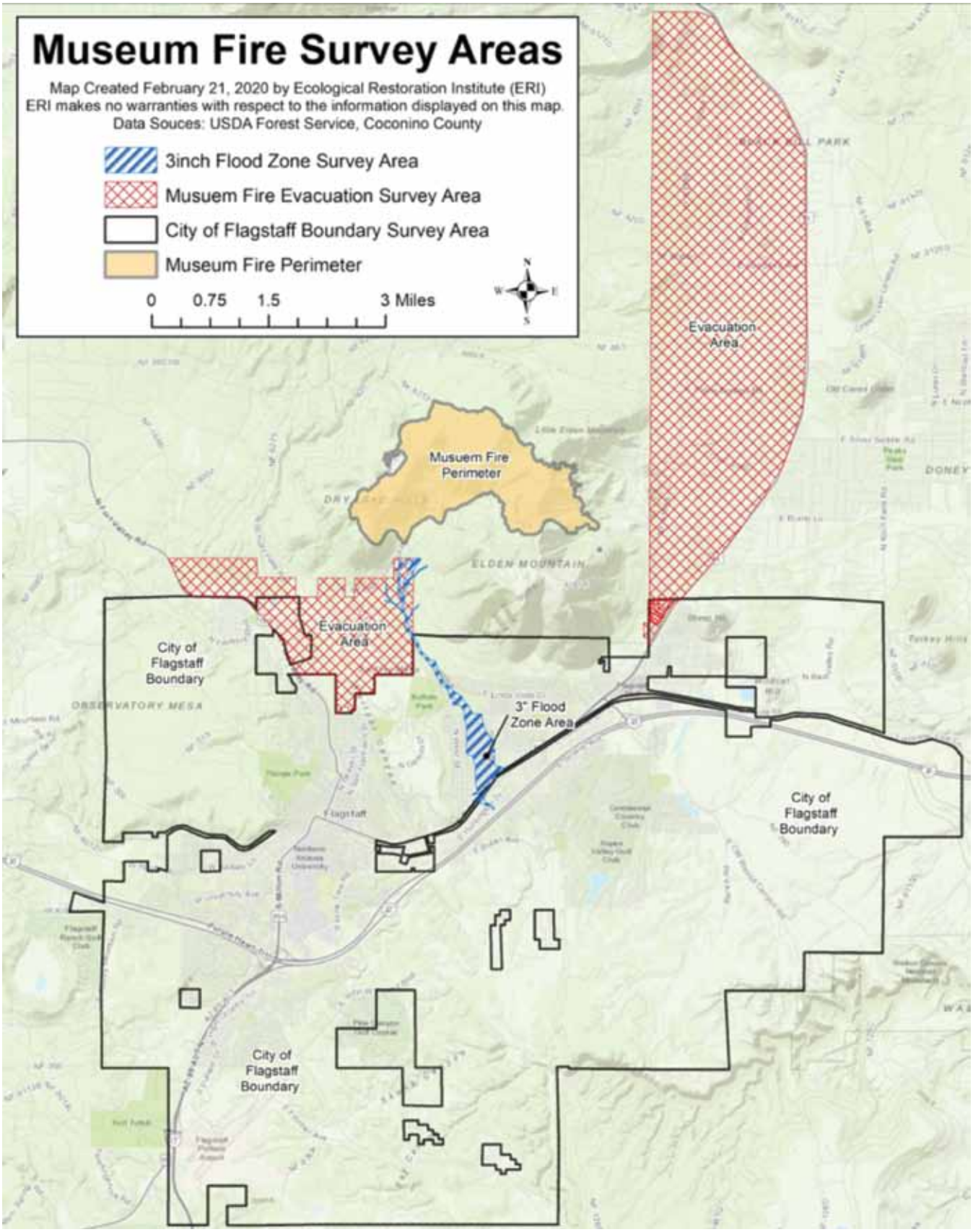

Figure 1. Map of areas affected by the Museum Fire. Data sources: USDA Forest Service (Museum Fire evacuation area); Coconino County (3-inch flood depth area)

the Flagstaff Community Forum (FCF) website and social media, and associated email requests were sent to members of their listserv. This forum is available for any member of the public, meaning that responses were collected via convenience sampling. An additional 169 questionnaires were completed through this site that bared no statistically significant differences to responses received via the mail survey sample. We received a total of 786 surveys (see Table 1 for an overview of responses by location).

Table 1. Survey responses by area and administration method

	Mail survey			FCF	
	Delivered	Responses	Response rate	Responses	**Total responses**
Fire evacuation area	1,144	267	23.34%	24	291
Flood risk area	359	84	23.40%	10	94
City limits	1,255	266	21.20%	132	398
Unknown*	N/A	N/A	N/A	3	3
					786

* "*Unknown" indicates surveys where respondents declined to answer questions about their location or removed survey tracking numbers from their booklet.*

The questionnaire collected information across five broad topics: (1) the respondent's experience with the Museum Fire; (2) communication of emergency information during the Museum Fire; (3) evacuation experiences and the *Ready, Set, Go* evacuation system; (4) opinions regarding forest management in the Flagstaff area, including the FWPP; and (5) basic demographic information. Space was provided for additional comments on the last page. Survey materials are included in Appendix 1.

Resident Experiences with the Museum Fire

Fire and Flood Risk

One of the defining characteristics of post-fire flood risk is its prolonged presence, often remaining a threat for years after the original fire event. Flood risk became a growing concern as the Museum Fire burned, driven in part by local experience with post-fire flooding from the 2010 Schultz Fire. Understanding risk perceptions associated with fire and subsequent flooding can support the development of more streamlined communication and outreach efforts over the coming months to years.

Survey participants were asked to estimate the likelihood of wildfires and post-fire flooding occurring on a range of spatial scales in the next ten years. Table 2 shows responses stratified across sampling areas. Respondents within the broader city limits indicated a higher likelihood of fire occurring on private property in Coconino County and Flagstaff, while those who were in the evacuation area during the Museum Fire perceived the highest likelihood of their own property being damaged. Those in the flood risk area generally anticipated a higher likelihood of post-fire flooding.

Given that respondents anticipated a higher likelihood of post-fire flood risk at a range of scales in the next 10 years (Table 2), identifying their willingness to support continued mitigation efforts such as sand bags and Jersey barriers can help streamline risk reduction outreach. Flagstaff-area residents participating in this survey broadly agreed with each of the statements shown in Table 3; however, those in the flood risk zone consistently exhibit lower agreement than the other two zones. Broader trends across these data indicate that 41.3% of respondents in the flood risk zone strongly agreed with the statement "flood risk reduction efforts should stay in place until flood risk has subsided" in comparison to 45.9% in the city limits and 51.4% in the fire evacuation area. Respondents within the city limits and fire evacuation areas are less likely to interact with flood mitigation efforts on a daily basis.

Table 2. Perceived likelihood of future hazard event impacts. Survey participants were prompted to answer the following question: "Please indicate the likelihood that the following events will occur during the next 10 years." Percentages shown are average scores, with the highest survey zone average indicated in bold (for example, respondents in the flood risk area anticipate that there is a 98.7% chance that a wildfire will occur in Coconino County between 2020 and 2030).

	Fire evacuation area	Flood risk area	City limits
A wildfire occurs anywhere in Coconino County	98.4%	**98.7%**	98.0%
A wildfire occurs on private property in Coconino County	85.8%	78.4%	**87.9%**
A wildfire occurs within Flagstaff City limits	68.6%	68.2%	**74.6%**
A wildfire damages a neighborhood in the City of Flagstaff	51.7%	49.8%	**56.0%**
A wildfire damages your Coconino County home	**30.1%**	24.0%	25.3%
A post-fire flood occurs anywhere in Coconino County	88.9%	**89.4%**	88.7%
A post-fire flood occurs on private property in Coconino County	80.9%	79.6%	**81.7%**
A post-fire flood occurs within Flagstaff City limits	71.1%	70.7%	**73.5%**
A post-fire flood damages a neighborhood in the City of Flagstaff	63.5%	**65.7%**	65.3%
A post-fire flood damages your Coconino County home	23.7%	**38.9%**	8.8%

Table 3. Respondent perceptions of flood risk reduction efforts after the Museum Fire.
Survey participants were prompted to answer the following question: "Please indicate the extent to which you agree or disagree with the following statements about flood risk reduction efforts (e.g., sandbags, road closures)." The Likert scale response with the highest percentage of respondents is shown in bold.

Flood risk reduction efforts	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
Should stay in place until flood risk has subsided	5.8%	5.1%	9.1%	32.8%	**47.3%**
Have made some areas of Flagstaff unattractive	4.5%	6.4%	21.8%	9.6%	**27.8%**
Are inconvenient	10.7%	12.8%	**31.7%**	1.3%	13.6%
Are appropriate given the current risk	3.7%	5.4%	7.3%	34.5%	**49.1%**
May need to stay in place for years	8.4%	11.6%	20.1%	**35.8%**	24%

Communication During the Museum Fire

Transparent and clear communication about developments during and after fire events is critical for public safety and relationship building between communities and agencies. A variety of organizations and agencies shared information about fire risk, evacuation, suppression progress and resource availability with the public via various communication platforms during the Museum Fire. These included public meetings, social media postings, and online updates via official agency websites. Coconino County has its own alert system for rapid communication during emergencies that residents can opt-in to receive via text or email — 84.4% of survey respondents stated they were signed up for emergency alerts during the Museum Fire.

Three hundred and twelve (39.7%) survey respondents attended meetings focused on information dissemination about the Museum Fire, while 203 (25.8%) attended meetings about post-fire flood risk. Notably, more respondents attended both meetings "virtually" (n = 296, 37.6%) via Facebook live or the City of Flagstaff website than did in person (n = 221, 28.1%). Figure 2 shows meeting attendance divided by surveyed area.

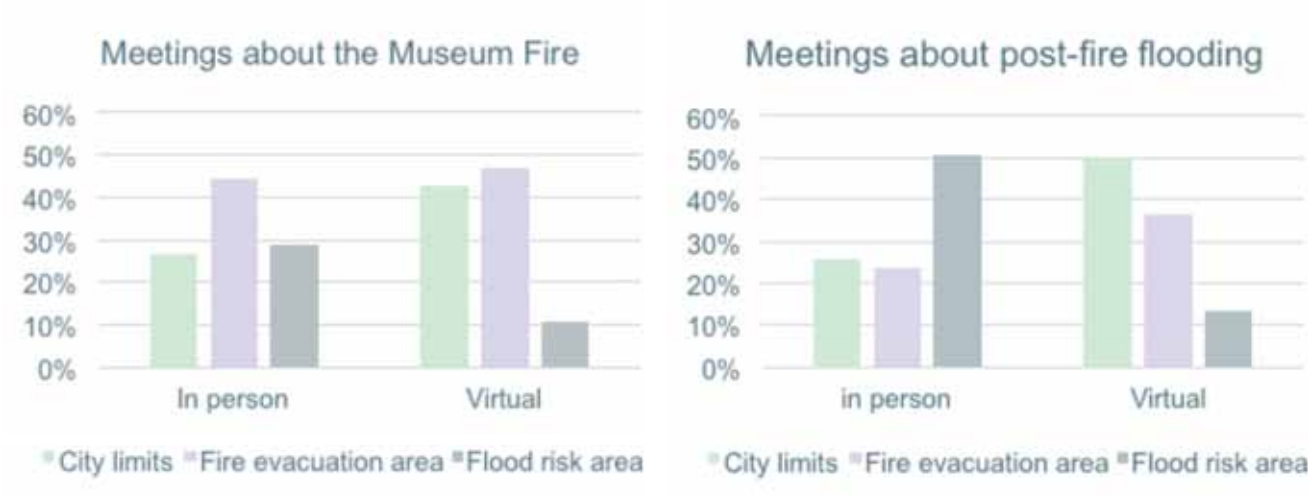

Figure 2. Attendance at meetings associated with the Museum Fire and associated post-fire flood risk. Data are presented by mode of attendance across each of the three sample zones.

Survey participants were most trusting of organizations and agencies that operated at the local level (Table 4). Importantly, 29.1% of respondents did not use Inciweb, a centralized national website for vetted fire incident information. Respondents expressed the highest level of trust in the US Forest Service, which may be because the Museum Fire burned predominantly on National Forest System land.

Survey respondents were also asked to indicate their response to the following question: "How do you expect to be notified about a wildfire or flood event that threatens your Flagstaff home?" (Table 5). Participants most frequently indicated that they expect to receive notifications via the Coconino County emergency alert system, aligning with the high number of respondents who stated that they had signed up for this system as reported earlier. Some respondents provided comments describing that while they themselves were not signed up, someone else in their household was. This may explain the marginal difference in these statistics.

Table 4. Trustworthiness of information sources during the Museum Fire.
Survey participants were prompted to answer the following question: "How trustworthy or untrustworthy were the following sources of information for making decisions about risk posed to your household related to the Museum "Fire?" The response with the highest percentage of respondents is shown in bold.

	Very trustworthy	Somewhat trustworthy	Neutral	Somewhat untrustworthy	Very untrustworthy	I didn't use this source
US Forest Service	**61.2%**	17.6%	6.6%	3.2%	3.4%	7.9%
My local fire department	**55.7%**	10.8%	10.6%	0.9%	1.3%	20.6%
Law enforcement (e.g. Sheriff's Office)	**49.9%**	18.5%	11.8%	2%	1.7%	16%
Coconino County	**48.3%**	25.2%	11%	3.4%	1.9%	10.2%
The City of Flagstaff	**40.9%**	24.2%	15%	5.4%	2.9%	11.5%
Inciweb	**36.6%**	14.8%	16.2%	1.8%	1.5%	29.1%
Media (e.g., newspapers, TV news, radio)	20.2%	**43.7%**	18.7%	9.4%	3%	5%
My family and friends	19.4%	27.6%	**32.3%**	5%	1.2%	14.4%
My neighbors	12.8%	29.2%	**32.4%**	9.3%	2.2%	14.1%
Internet searches	8.3%	**40.9%**	25.7%	11.2%	1.9%	12.1%
Neighborhood groups (e.g., Homeowners Association)	8.2%	16%	**31.2%**	6%	2.2%	36.4%
Social groups (e.g., recreation clubs)	3.5%	11.2%	**32.6%**	9.2%	2.8%	40.7%

Table 5. Anticipated mode of communication during wildfire and flood risk
Survey participants were prompted to answer the following question: "How do you expect to be notified about a wildfire or flood event that threatens your Flagstaff home?" Participants could select multiple responses.

Communication outlet	Percentage of respondents
The Coconino County emergency alert system	88.8%
Local news outlet (e.g., Newspaper or TV)	51.4%
My neighbors or family members	48.4%
City of Flagstaff government	43.5%
An in-person visit from a local official	41.0%
Social media (e.g., Facebook, Twitter)	31.8%

Subsequent questions asked specifically about social media use to locate local emergency information; 59.3% of respondents stated that they use at least one social media platform for this purpose. Facebook was the most common platform (44.3% of respondents), followed by online community forums like Nextdoor (18.2%) and Twitter (13.3%).

Overall, respondents agreed that communication about the Museum Fire and subsequent fire risk was clear (strongly agree = 34.8%; moderately agree = 39.2%). A majority of respondents agreed with the statement: "Enough information was available for me to make decisions about the safety of my home" (strongly agree = 35.2%; moderately agree = 42.5%). Those surveyed within the city limits sample area were most likely to agree with that statement, while those in the flood risk area were most likely to disagree.

A variety of organizations and agencies shared information with the public about fire risk, evacuation, suppression progress, and resource availability during the Museum Fire, including public meetings, social media postings, and online updates via official agency websites. *Photo by Catrin Edgeley*

Evacuation

A vast number of homes in the Flagstaff area were placed under evacuation through the *Ready, Set, Go* notification system (*RSG*) during the Museum Fire. The system advises that residents in fire prone areas should always be "Ready" for fire by maintaining defensible space around their properties and having essentials accessible in case a fire does threaten their home. The "Set" stage is initiated to notify residents of the possibility that they might need to evacuate. The "Go" stage is initiated to notify residents that it is time to evacuate. Just over half (54.5%) of respondents stated that their residence was placed under evacuation warning through the *RSG* system. When asked which level(s) their property was placed under, responses were distributed as follows:

- 21.4% of respondents said their home was at the "Ready" stage
- 33% of respondents said their home was at the "Set" stage
- 5.2% of respondents said their home was at the "Go" stage

A subset of respondents reported that their home was placed under more than one warning stage (e.g., shifting from "Set" to "Go"). A small number (7.8%) of respondents reported that they evacuated their household due to wildfire risk, with an additional 0.3% evacuating due to flood risk. These evacuees were not necessarily placed in the "Go" stage of *RSG*, meaning that they may have proactively decided to evacuate or that other factors beyond this survey influenced decision making (e.g., smoke impacts). Approximately 14.5% of survey respondents had evacuated due to a wildfire prior to the Museum Fire, whether it was at their Flagstaff residence or at another property they had once lived in during their lifetime.

Public interpretation of the *RSG* tiered evacuation system remains under-researched in the emergency management literature. Questions asked survey recipients to indicate the extent to which they agreed or disagreed with a range of statements related to interpretation of *RSG*. Table 6 provides an overview of these data. Respondents who were in the fire evacuation area indicated a slightly higher understanding of the *RSG* system, likely given their recent experience navigating it. Responses indicate residents' uncertainty about two key areas of *RSG*: (1) Whether all three levels of the *RSG* system would occur during a fire; and (2) how they will be contacted regarding their home's evacuation stage.

Table 6. Respondent understandings of the Ready, Set, Go evacuation system.
Survey participants were prompted to answer the following question: "Please mark to the extent to which you agree or disagree with the following statements about the Ready, Set, Go evacuation system." The Likert scale response with the highest percentage of respondents is shown in bold.

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
The *Ready, Set, Go* warning system for evacuation is clear	2.5%	4.3%	6.7%	35.9%	**50.6%**
The *Ready, Set, Go* warning system is the best way to ensure the safety of residents in my community	1.6%	3.4%	19.9%	37.5%	**37.7%**
The *Ready, Set, Go* warning system will not affect my plans during a wildfire	**44.2%**	29.3%	15.1%	6.4%	5.1%
Residents only need to evacuate if they are contacted as part of the *Ready, Set, Go* warning system	20.2%	**29.2%**	19.8%	18.5%	12.4%
All three levels of the *Ready, Set, Go* warning system will occur during wildfires	21.6%	17.4%	**23.7%**	16.5%	20.7%
I know how I would be contacted about evacuation using the *Ready, Set, Go* system	9.8%	15.3%	13.9%	**33.2%**	27.7%

Existing studies suggest that residents living in fire-prone areas often have high expectations regarding in-person contact to initiate evacuation. In areas with larger populations like Flagstaff, or in a scenario where a fire is fast-moving, this is often unattainable. Table 7 shows resident assessments of broad community expectations for in-person notification across survey sampling zones. Overall, respondents showed high agreement with the statement "People expect to be notified by professionals about when to evacuate." When asked whether the respondent personally expected to be notified in-person about evacuation, 40.1% said yes.

Table 7. Resident expectations of in-person evacuation notifications. Survey participants were prompted to answer the following question: "Please mark to the extent to which you agree or disagree with the following statement: "People expect to be notified by professionals about when to evacuate." The Likert scale response with the highest percentage of respondents is shown in bold.

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
City limits	1.0%	0.5%	5.4%	18.8%	**74.2%**
Evacuation area	0.0%	1.7%	5.2%	0.8%	**72.2%**
Flood risk area	2.2%	0.0%	6.5%	16.1%	**75.3%**

Fire and Forest Management

One section of the survey was dedicated to understanding resident perceptions of fire and forest management, both during the Museum Fire and in the future. Responses related to the Museum Fire and management were positive overall; select examples include:

- 66.5% agreed Flagstaff was well prepared for an event like the Museum Fire (18% strongly agreed, 48.5% moderately agreed).
- 90% agreed that firefighting response to the Museum Fire was adequate (71.5% strongly agreed, 18.5% moderately agreed).

Survey respondents demonstrated a high level of understanding regarding fire ecology in their responses associated with the role of landscape health and fire (see Mottek Lucas 2015 for background on community outreach efforts). An overwhelming majority of respondents recognized that "fire is a natural part of the landscape around Flagstaff (53.3% strongly agree; 33.2% moderately agree), indicating a higher social acceptability of fire activity in the area. Additionally, there was strong agreement that the landscape would recover from impacts introduced by the Museum Fire (34.5% strongly agree; 39.6% moderately agree).

The Museum Fire significantly impacted ongoing FWPP implementation work, burning two log decks being offered for sale by the Forest Service and awaiting removal. This photo series shows one of the log decks awaiting sale before the Museum Fire (above), and the same area after the fire burned the logs (below). *Photo by Melanie Colavito*

This survey was delivered to residences shortly after the conclusion of an investigation to identify the source of the fire's ignition; a US Forest Service press release shared widely by the media reported the outcome as likely caused by an isolated spark from contractor equipment affiliated with FWPP fuel treatment. The identification of a human-caused source might explain why 57.6% of respondents strongly or moderately agreed that "the Museum Fire was preventable." Additionally, 30.7% of respondents strongly or moderately agreed with the statement, "the Museum Fire was not a typical fire for this area."

Many respondents indicated that they felt recreation had been negatively impacted by the Museum Fire (37% moderately agreed, 26.9% strongly agreed).

Public acceptance of forest management outcomes is often a key indicator of their support for future risk mitigation efforts. Figure 3 shows how acceptable or unacceptable survey respondents found various management outcomes to be in the Flagstaff area. Acceptance remained relatively high across all outcomes (>60% of respondents found approaches moderately or very acceptable) with the exception of smoke or reduced air quality (31.8% moderately acceptable; 8.8% very acceptable). However, prescribed fire was one of the most accepted outcomes (35.6% moderately acceptable; 42.8% very acceptable); this contradiction highlights the challenges of management tactics that have consequences beyond public land such as reduced air quality.

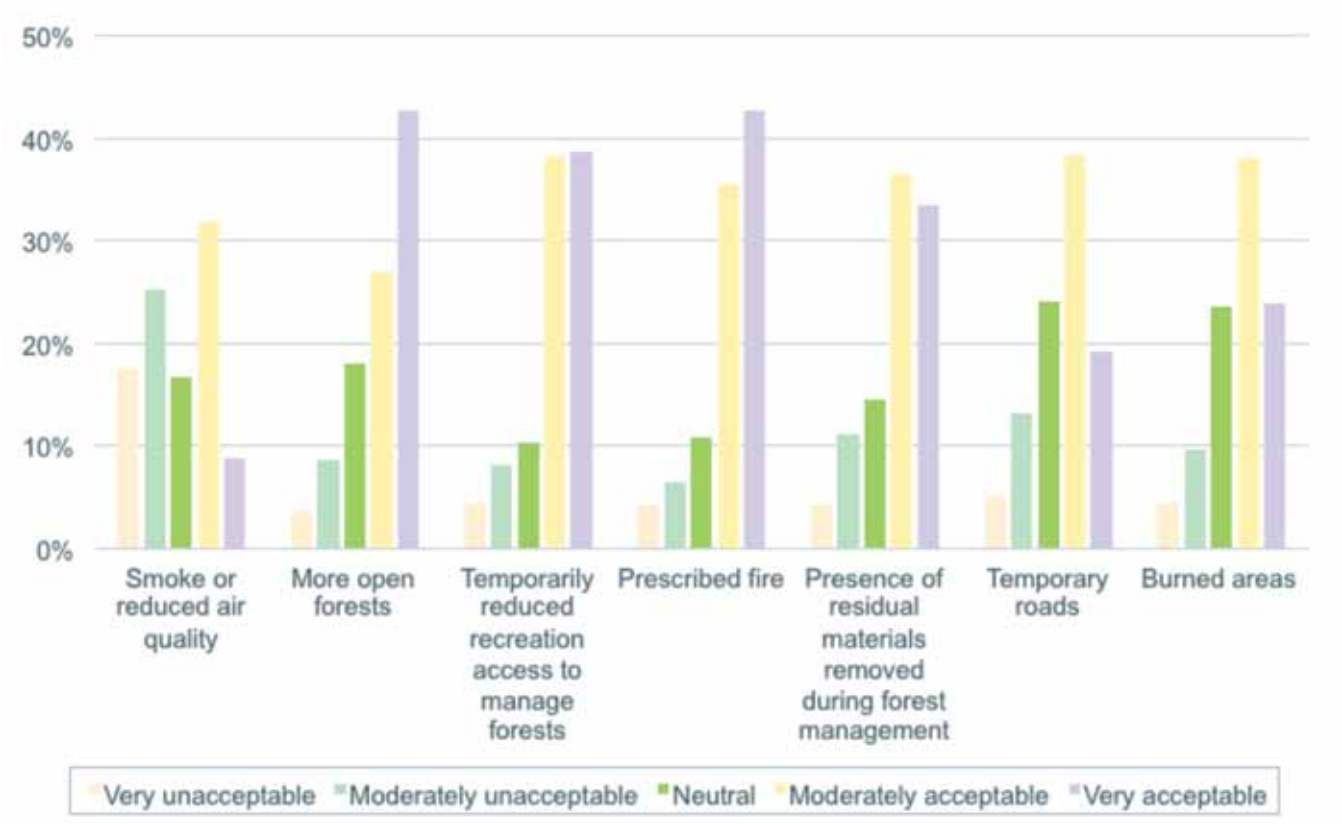

Figure 3. Acceptability of different forest management outcomes. Survey participants were prompted to answer the following question: "Please indicate how acceptable or unacceptable you find the following forest management outcomes."

Willingness to Pay for Forest Management

Respondents were asked how they would like to see future forest management funded in the Flagstaff area. Outcomes are shown in Table 8. Increased utility fees were the most unacceptable approach for survey respondents, with moderate acceptance of increased city and property taxes. Respondents were also invited to provide other options they might support; these ranged from additional taxes on tourism (e.g., BBB [Bed, Board, and Booze] tax), shifts in federal funding of public land management budgets, and increased fees for recreation through trailhead parking.

Table 8. Acceptability of future forest management funding avenues. Survey participants were prompted to answer the following question: "Please indicate how acceptable or unacceptable you find the following strategies for financing forest management to reduce wildfire risk in the Flagstaff area." The Likert scale response with the highest percentage of respondents is shown in bold.

	Very unacceptable	Moderately unacceptable	Neutral	Moderately acceptable	Very acceptable
Increased city taxes	21.6%	14.6%	17.5%	**36.5%**	9.8%
Increased property tax	24.4%	17.4%	15.5%	**32.6%**	10.2%
Increased fees for household utilities	**34.2%**	24.7%	17.5%	17.5%	4.9%
No additional fees for forest management	18.1%	20.6%	**34.4%**	13.5%	13.4%

Existing support for publicly funded forest management, such as FWPP, offers the opportunity for similar efforts in the future. At least 24.2% of survey respondents were not willing to pay any amount, indicating $0 per month. A further 18.3% opted not to answer this question. However, 57.5% of respondents were willing to pay some amount; Table 9 shows the outcomes of this effort, stratified by annual household income. The amount that households are willing to pay toward forest management is directly connected to household income; households earning above $150,000 per year show a marked increase in the amount they are willing to contribute. A 2012 survey conducted by Mueller (2014) found that Flagstaff residents were willing to pay $4.89 a month to contribute to forest restoration. Our survey sought to replicate this open-ended question format that allowed respondents to write in any dollar amount. Our survey showed a significant increase in willingness to pay since Mueller's study, with a mean response of $18.58. This difference may be driven by different question framing; our survey asked about willingness to pay for wildfire risk reduction rather than forest restoration.

Table 9. Variations in willingness to pay across survey sample groups, stratified by reported annual household income. For reference, the average household income per fire area is: Fire evacuation area: $80,000–99,000, Flood risk area: $60,000–79,000, City limits: $60,000–79,000.

	Evacuation area		Flood risk area		City limits		Total	
Annual household income before taxes	Mean	N	Mean	N	Mean	N	Mean	N
Less than $20,000 per year	$0.00	5	$2.50	4	$8.64	14	$5.70	23
$20,000 to 39,999 per year	$10.50	10	$11.00	11	$15.27	26	$13.26	27
$40,000 to $59,999 per year	$15.90	29	$10.42	12	$13.77	42	$14.46	82
$60,000 to $79,999 per year	$12.86	28	$13.54	6	$16.98	46	$15.28	80
$80,000 to $99,999 per year	$10.04	26	$15.63	8	$17.11	35	$14.28	69
$100,000 to $149,999 per year	$23.63	60	$23.40	15	$18.27	66	$21.10	141
$150,000 to $199,999 per year	$33.33	27	$7.29	7	$18.62	29	$23.67	63
$200,000 to $249,999 per year	$34.50	14	$28.33	3	$22.22	9	$29.54	26
$250,000 or more per year	$37.76	17	$56.67	3	$22.69	13	$33.55	33
Total	**$21.44**	216	**$16.22**	69	**$16.85**	280	**$18.58**	566

Flagstaff Watershed Protection Project

The initial success of the FWPP has driven much discussion and public interest around how it might be sustained or replicated in the future (Mottek Lucas 2015). Among our survey respondents, 39.2% voted in support of proposition 405 in 2012; 2.2% voted in opposition; 25% couldn't remember how they voted; 3.5% didn't vote; 29.6% didn't live within the Flagstaff city limits in 2012; and 0.5% were not yet old enough to vote.

Respondents overwhelmingly agreed that collaborative management efforts across agencies, governments, and organizations were the best way to address fire risk to Flagstaff (Figure 4). Many also expressed that more money should be invested in the FWPP (24.7% strongly agreed, 31.7% moderately agreed). This support was confirmed by high agreement among participants that they would support future initiatives like FWPP to reduce wildfire and flood risk in Flagstaff (34.7% strongly agreed, 38.6% moderately agreed). This support for collaborative approaches, combined with findings presented above, indicate that Flagstaff residents selectively support management mechanisms that operate at the local level and focus on public lands.

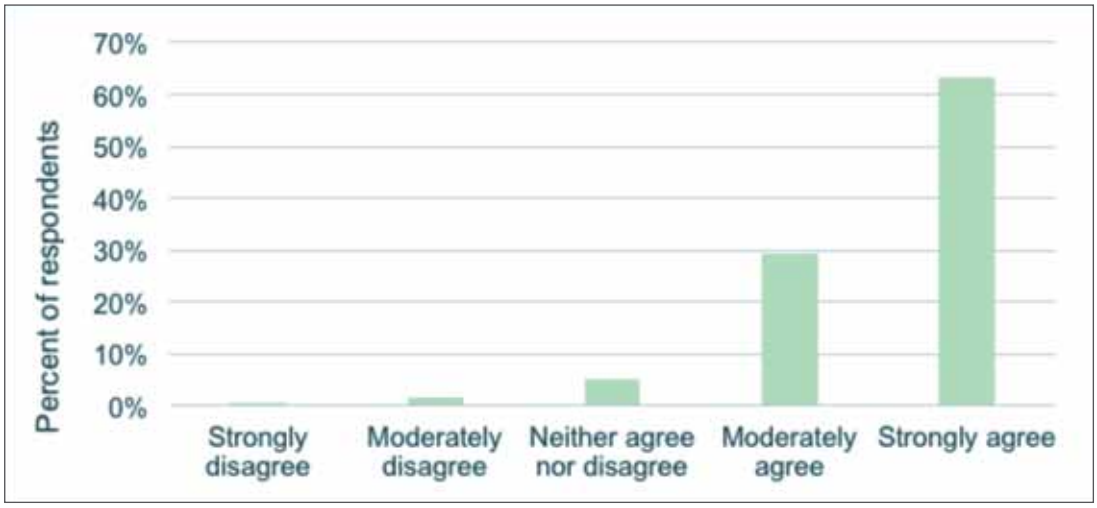

Figure 4. Support for partnerships to address Flagstaff's wildfire risk. Survey participants were prompted to answer the following question: "Please indicate the extent to which you agree or disagree with the following statement: Partnerships between the City, U.S. Forest Service, and other organizations are the best way to address fire risk to Flagstaff."

More than half of survey respondents disagreed with the statement "efforts like the FWPP mean that less action is needed to address fire risk on my private property" (24% strongly disagreed, 31.8% moderately disagreed). Survey data suggest there is a significant subset of residents in the Flagstaff area who recognize their responsibility to reduce risk on their own land; this perspective aligns with a large body of existing literature on responsibility for risk mitigation on private property (e.g., Martin et al. 2009, McFarlane et al. 2012, Edgeley and Paveglio 2019).

Additional Respondent Comments

Space was provided at the end of the survey for respondents to share any additional thoughts or comments related to the Museum Fire. This resulted in 219 comments. Comments typically fell under three broad themes:

1. Support for Higher Regulation of Forest Use

Numerous comments detailed concerns related to campfire restrictions on Coconino National Forest and other public lands in the Flagstaff area. Many indicated that they felt the highest risk of human-caused wildfire came from tourists visiting from outside the area who may not be as familiar with local forest etiquette. Although the reported cause of the Museum Fire was not a campfire, this likely emerged from longstanding concerns related to the 2010 Schultz Fire, which was caused by an escaped campfire, and broader conflicts surrounding forest use between locals and visitors. Typical comments addressing this issue explicitly asked for tighter restrictions during periods of high fire risk:

> *"So long as tourism is promoted, Flagstaff will have increased wildfire risk. Visitors have no comprehension of the risk. People who come from the deserts to "cool off" should not be lighting fires! Start a "Bring a sweater" campaign."*

> *"Camping and fire bans should be considered and implemented way sooner than they generally are. We should NOT be thinking about tourism dollars when making these decisions. We should be thinking ONLY of preventing catastrophic fire, which is mostly/often caused by humans."*

> *"I strongly believe that when fire risk is high, we need more regulations, such as closing areas to vehicle traffic, banning campfires, banning commercial operations that pose a risk, etc."*

Coconino National Forest has expanded their existing year-round campfire ban by 25,000 acres surrounding Flagstaff since this survey was conducted (Buffon 2020). The FWPP Environmental Impact Statement also included a campfire ban in the Dry Lake Hills project area that was enforced at the time the Museum Fire occurred in response to public comments during the public involvement process.

2. Clarification over Emergency Communication

Many respondents expressed confusion or uncertainty around emergency notifications related to the Museum Fire. Most frequently, these comments were related to the RSG system. Their predominant concern was a lack of "all clear" alerts informing residents that they were either downgraded or no longer placed under any stage of the RSG system, requiring them to rely on other less reliable sources or word of mouth to determine when to return to their residence. Comments about RSG were diverse:

> *"My only issue with the notification process was the decision to stop notifying by text when evacuation levels were reduced. Initially, we were notified when areas went from 'go' to 'set' or 'set' to 'ready.' Later, the County decided not to make this text notification so it was difficult to figure out if my neighborhood was downgraded from 'set' to 'ready' when containment increased; this felt particularly important because containment lines around a hot spot near my neighborhood had not been established when less reliable social media sources were reporting the status change."*

> *"The implementation of 'Ready, Set, Go' was not ideal. There was a lot of confusion out there as to what it meant, how people would find out, etc. I don't think our neighborhood was ever officially told when we were out of 'Set.' I even tried calling the official information number and a) the published open times were incorrect and b) once I finally talked to someone, they weren't very nice and I don't think that particular individual was well informed as to the situation."*

> *"My neighborhood was put on 'set' evacuation status the day after the fire started. We were told we would be notified by the Coconino County alert system when our neighborhood was taken off 'set' and back to 'ready.' This NEVER happened and the only notification we received was by watching the Phoenix news station. This severely compromised my trust in Coconino County and their ability to communicate with 90% of the people who were put on the 'set' evacuation notice."*

Other comments expressed uncertainty caused by the misnaming of neighborhoods placed under evacuation; for example, some respondents reported that Lockett Estates was listed as Locket Meadows, leaving some households unclear about whether evacuation notifications applied to them. Concerns regarding RSG may not be unique to Flagstaff, and communities across the West may be experiencing similar challenges and complications.

3. Reported Cause of the Museum Fire

In an earlier section of the survey, 82.8% of respondents indicated that they were aware of the reported cause of the Museum Fire. Many comments questioned the reported cause or requested that the full Forest Service report be released. Many respondents provided comments that highlighted change or lack of change in support for continued forest management. Two examples of opposing arguments are shown below:

> *"Horribly sad that the Museum Fire was caused by FWPP worker. But this sad accident should not reduce our commitment to FWPP and similar projects. Instead we should plan and implement them faster (but more carefully)."*

> *"The cause of the fire was tragic and in fact squandered the resources already extracted from local citizens. I don't think citizens should be asked or required to provide further resources until a full accountability of the cause is made, remediation of procedures and oversight achieved, and avenues of reinsurance* (sic) *explored to protect citizens from further squandering of their resources in the future."*

Themes within these kinds of comments highlighted that a subset of residents expect changes to how FWPP is funded or greater transparency around the role of fuel treatments in relation to the Museum Fire before they would consider supporting a similar approach again. These comments typically requested financial information on the status of FWPP, and for specific strategies or approaches that would be implemented to prevent a similar ignition from contractor equipment occurring again. However, as noted earlier, 73.3% of respondents strongly or moderately agreed that they would support future initiatives like FWPP, so it is possible that these comments were provided by a non-representative minority within the Flagstaff community. This percentage of respondents in support is strikingly similar to the percentage of residents who voted in support of the city bond that supported FWPP in 2012 (Nielsen and Solop 2013).

> *"I strongly believe that when fire risk is high, we need more regulations, such as closing areas to vehicle traffic, banning campfires, banning commercial operations that pose a risk, etc."*
>
> *— Survey respondent in support of higher regulation of forest use*

Management and Policy Implications

Survey findings indicate that Flagstaff-area residents retained positive attitudes toward forest, fire, and flood risk management in the months following the Museum Fire. We provide evidence-based suggestions for decision-makers below that can maintain and advance successful efforts to support community adaptation and safety during wildfire and post-fire flood risk.

Communication During the Museum Fire

- The virtual public meeting format used to communicate with residents during the fire was well attended. Officials should continue to stream in-person meetings on multiple platforms to reach a wider audience.
- Residents are most trusting of organizations and entities from the local community, such as the local Forest Service units and local fire departments. These entities should be used to communicate with the public during fires.
- Inciweb, a centralized website for fire incident information, is not highly utilized by residents, and could be better shared as a resource.
- Overall, fewer residents found communication of information about flooding clear, perhaps because it was not relevant to them. Nonetheless, local entities responsible for communicating about flood risk may need to provide more detailed information for residents to make decisions about the safety of their homes regarding flood risk.
- Some residents share the expectation that they will be notified in-person by professionals about when to evacuate during a wildfire or flood event. In most cases, this is likely to be unfeasible as there is not enough time or capacity for professionals to visit all affected households. This finding suggests that residents need to be better equipped with the knowledge to make decisions about when to evacuate without supervision. This may necessitate more effective communication of the *Ready, Set, Go* system (see section below) or other thresholds that might encourage self-evacuation. Officials should also clearly state in public meetings and other communication forums that in-person contact about evacuation will likely not occur.
- Many residents have signed up for the Coconino County alert system and received alerts via the system during the Museum Fire. The county should continue to use the system to communicate to residents during an emergency, and maintain efforts to encourage residents to sign up for alerts wherever possible.

Ready, Set, Go *Evacuation Notification System*

Data collected in this survey indicate that while *RSG* is clear to residents in theory, there is confusion regarding the implementation of this system in practice — regardless of whether they had evacuated using the *RSG* system or not during the Museum Fire. Clarification around *RSG* and communication to improve evacuation safety more broadly can take several forms:

- High dependence on official evacuation notices among survey respondents indicates a clear need to provide residents with knowledge that can help them make evacuation decisions autonomously. Creating and sharing resources and information to residents about fire behavior, possible thresholds for evacuation, and evacuation decision making can encourage a reduced reliance on in-person communication and increase public safety.
- Many residents understand the *RSG* system in theory but not in practice; notably, there is confusion regarding whether all three levels will occur, and whether they will be announced incrementally from "ready," to "set," to "go." Wider communication about the *RSG* system in advance of fire season, with more details about how it may be implemented under different scenarios, will help clarify this uncertainty.
- Advanced public listing of outlets where *RSG* evacuation warnings will be communicated and updated can streamline public information receipt during fires. Survey findings indicate that many Flagstaff residents are signed up for the Coconino County emergency alert system, but are not aware that they will receive evacuation notices through that platform. Providing resources that help residents connect communication systems with their uses could alleviate stress and encourage the use of trustworthy information sources during wildfires.
- Many residents were confused by incorrect place names in evacuation notices during the Museum Fire (e.g., Lockett Ranches referred to as "Locket Meadows"). Confirmation that neighborhood or subdivision names are accurate in emergency messaging before they are publicly shared will reduce confusion and improve public response time to notifications. Use of maps can eliminate further uncertainty associated with diverse names used by different populations for the same location.
- While communicating about evacuation as the fire approaches is critical, numerous survey respondents were uncertain about when it would be safe to return to their homes once the threat had subsided. Many expected to be notified that *RSG* for their neighborhoods had been lifted or relaxed through the Coconino County emergency alert system, but did not receive any information through this channel. Clear communication about (1) when and where RSG evacuation notices have been lifted or reduced a level, and (2) where residents will be able to access the most up-to-date information about their neighborhood will be beneficial for evacuees during future fires.

Many challenges associated with the implementation of *RSG* are not unique to Flagstaff; however, Flagstaff's local and county government have consistently demonstrated a high capacity for implementing and improving wildfire adaptation efforts. Lessons learned from resident experiences with *RSG* offer another opportunity for Flagstaff to further improve the safety of its residents.

Post-Fire Flood Risk

Local experiences with the Schultz Fire in 2010 influenced public perceptions and expectations for flooding and flood risk management following the Museum Fire (McMannis 2019). As flood risk is likely to remain in areas downslope of the burned area, addressing resident concerns and misconceptions remains extremely important. Findings from this survey support the following management implications:

- Flagstaff residents have a strong understanding of the connectivity between wildfires and post-fire flooding; however, those who are evacuated in fire risk areas often have different experiences and perceptions to those in flood risk areas that should be considered during communication and outreach.

- Maintaining communication about post-fire flood risk between local agencies and residents is critical to encourage continued awareness downslope of the Museum Fire burn scar. Lower risk awareness and support for long-term mitigation to address post-fire flooding by residents in the flood risk area suggests that these efforts should span multiple years, and can also benefit from communication more broadly across the population to maintain support both city-wide and in the greater Flagstaff area.
- Rapid public communication, such as public meetings held in-person and virtually, about flood risk while the Museum Fire was still burning was well received and well attended by residents throughout the Flagstaff area. Officials should continue to introduce flood risk information early and through a range of communication channels.
- Residents indicated willingness to see flood mitigation efforts, such as sand bags and Jersey barriers, maintained in order to reduce future flood risk. However, residents in the flood risk zone were less likely to state that flood mitigation measures should be maintained, suggesting they may be experiencing some fatigue in living with the mitigation measures during an unusually dry monsoon season. This might warrant additional communication with these areas about the reasons for keeping the measures in place.
- Those within the city limits and fire evacuation areas are less likely to interact with flood mitigation efforts on a daily basis and may not need the same level of targeted outreach as those within the flood risk area.

The lessons learned from the survey illustrate that addressing post-fire flood risk should largely focus on providing residents with information about why flood mitigation measures should remain in place, where they can access resources to supplement their flood mitigation measures, and how flood risk reduction efforts might be funded in the future. Providing residents with information about flood risk and mitigation will continue to be important, as the potential for flooding is still present despite recent dry monsoon seasons.

Flood risk is likely to remain in areas downslope of the burned area despite recent dry monsoon seasons. It is recommended that flood mitigation measures, like concrete barriers and sand bags around homes and property, remain in place. *Photo by Catrin Edgeley*

Forest and Fire Management

Fire events can be highly influential on community support for future land management efforts (McCool et al. 2004, Paveglio and Edgeley 2017). Survey findings indicate that although the conditions surrounding the Museum Fire concerned many residents, it did not substantially reduce their support for future forest management efforts. Findings from this survey support the following management implications:

- High public support for active forest management through proactive and collaborative approaches seems likely to continue following the Museum Fire.
- Survey respondents indicated a preference for collaborative forest management across agencies, governments, and organizations as a path forward to address wildfire risk and forest management. A significant portion of survey respondents stated their interest in FWPP continuation or the introduction of a similar bond format to reduce fire and flood risk in the future.
- Any effort to implement additional taxation for Flagstaff-area residents to support forest management may benefit from a prorated approach that takes annual household income into consideration.
- Residents recognize that they are responsible for reducing fire risk on their own properties. High awareness that FWPP does not reduce this need indicates that many Flagstaff residents are receptive to resident-focused outreach efforts and resources that they can use to manage vegetation and structure risk on their property. Practices that are shared and promoted among Flagstaff residents should highlight the benefits of shared responsibility for wildfire risk reduction.

Under these collaborative conditions, local government and land management agencies have a relative amount of flexibility given widespread public support for and recognition of the need for forest restoration and wildfire and post-fire flood risk reduction.

Conclusion

This white paper summarizes results of a survey about resident experiences with the 2019 Museum Fire in Flagstaff, Arizona to better understand the social impacts of wildfire and post-fire flooding. These results and associated management and policy implications provide evidence-based, actionable information for wildfire incident management teams, emergency managers, and city and county officials related to fire and post-fire flooding risk in communities-at-risk for wildfire. Specifically, these results include social data about resident experiences during the fire, communication about fire and post-fire flood risks, experience with and understanding of the *RSG* evacuation system, perceptions of forest management in the Flagstaff area and FWPP, and the Museum Fire cause. Findings highlight areas where future efforts can be focused to facilitate positive change. The results and recommendations provided here can also supplement community planning efforts to reduce wildfire risk and help to inform the development of actionable Community Wildfire Protection Plans (Colavito 2020).

The 2019 Museum Fire caused widespread impacts to Flagstaff-area residents that varied based on the risks posed to each household. Looking forward, Flagstaff officials can explore several paths forward for increasing public understanding of evacuation during fires and how associated decision making about evacuation works. Officials must also continue to communicate about prolonged post-fire flood risk and flood risk mitigation measures.

While public support for forest management to address fire risk and watershed health in Flagstaff remains high overall, these results illustrate that there are nuances about how much residents are willing to pay for restoration and flood risk reduction and show varied support for management outcomes. These nuances indicate that future public participation in forest management must incorporate greater flexibility to accommodate the diversity of resident backgrounds and perceptions.

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Appendix. Museum Fire Survey Booklet

Resident experiences with the 2019 Museum Fire

The Museum Fire was a wildfire that began on July 21st 2019 and burned 1,961 acres of land near the City of Flagstaff. This survey asks about your household's experience with the Museum Fire and post-fire flood risk to inform future management efforts.

To be completed by the adult in the residence (age 18 or older) who has had the most recent birthday and has the ability to make decisions about the property this survey was sent to.

NORTHERN ARIZONA UNIVERSITY

Ecological Restoration Institute

Survey ID:

Section 1: Your experience with the Museum Fire

This section of the survey will ask you about your experience with the Museum Fire to help us better understand the impact of this event on Flagstaff-area residents. Please answer these questions about the property this survey was delivered to.

Q1. Please mark which of the following statements apply to your Flagstaff home. *Please mark all that apply.*

- ○ My home was in an evacuation zone during the Museum Fire
- ○ My home was in the flood risk area during and after the Museum Fire
- ○ My home was not threatened by fire or flooding related to the Museum Fire

Q2. Did you evacuate from your home because of the Museum Fire? *Mark all that apply.*

- ○ Yes, due to wildfire risk
- ○ Yes, due to flood risk
- ○ No, I did not evacuate
- ○ I was not at my Flagstaff residence during the Museum Fire

Q3. Mark the statement(s) that best describe the level of insurance you have for the property this survey was sent to. *Please mark all that apply.*

	Yes, homeowners or renters insurance	**Yes**, flood insurance	**No**, this home was not insured	**N/A**
I purchased insurance **before** the Museum Fire	○	○	○	○
I purchased insurance **during or after** the Museum Fire	○	○	○	○

Q4. Did you attend any public meetings about the Museum Fire and/or subsequent flood risk? *Please mark all that apply.*

	I attended in person	I attended virtually (e.g. Facebook stream)	I did not attend
Public meeting(s) about **the Museum Fire**	○	○	○
Public meeting(s) about **post-fire flood risk**	○	○	○

Q5. Please indicate the extent to which the Museum Fire has improved or impaired your ability to undertake the following recreation activities in the Flagstaff area. *Please mark one answer for each statement. If you do not participate in a given recreation activity, mark N/A.*

	Significantly impaired	Moderately impaired	No change	Moderately improved	Significantly improved	N/A
Hiking	○	○	○	○	○	○
Mountain biking	○	○	○	○	○	○
Running or trail running	○	○	○	○	○	○
Bird watching or other wildlife observation	○	○	○	○	○	○
Other (please explain) _____	○	○	○	○	○	○

Q6. Please indicate the extent to which you agree or disagree with the following statements about your experience with the Museum Fire and/or post fire flood risk. *Please mark one answer for each statement.*

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
I lost sleep as a result of the Museum Fire or flood risk	○	○	○	○	○
I was worried about the safety of my property because of the Museum Fire or flood risk	○	○	○	○	○
I could not attend work because of the Museum Fire or subsequent flood risk	○	○	○	○	○
My health suffered as a result of the Museum Fire or flood risk	○	○	○	○	○
I often worry about the impacts that future fires or floods in this area could cause	○	○	○	○	○

Q7. Please indicate the likelihood that the following events will occur during the next 10 years. *For each option, fill in the chance that the event occurs; where 0 indicates a 0% chance and 100 indicates that you are 100% certain that event will occur.*

Wildfire risk

%	A wildfire **occurs anywhere in Coconino County**
%	A wildfire **occurs on private property in Coconino County**
%	A wildfire **occurs within Flagstaff City limits**
%	A wildfire **damages a neighborhood in the City of Flagstaff**
%	A wildfire **damages your Coconino County home**

Post- fire flood risk

%	A post-fire flood **occurs anywhere in Coconino County**
%	A post-fire flood **occurs on private property in Coconino County**
%	A post-fire flood **occurs within Flagstaff City limits**
%	A post-fire flood **damages a neighborhood in the City of Flagstaff**
%	A post-fire flood **damages your Coconino County home**

Q8. Please indicate the extent to which you agree or disagree with the following statements about flood risk reduction efforts (e.g. sandbags, road closures). *Please mark one answer for each statement.*

Flood risk reduction efforts …	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
…should stay in place until flood risk has subsided	○	○	○	○	○
…have made some areas of Flagstaff unattractive	○	○	○	○	○
…are inconvenient	○	○	○	○	○
…are appropriate given the current risk	○	○	○	○	○
…may need to stay in place for years	○	○	○	○	○

Section 2: Communicating about your safety in Flagstaff

This section of the survey will ask you about how information relating to the Museum Fire and post-fire flood risk was communicated to you.

Q1. How trustworthy or untrustworthy were the following sources of information for making decisions about risk posed to your household related to the Museum Fire? *Please mark one answer for each statement.*

	Very trust-worthy	Somewhat trust-worthy	Neutral	Somewhat untrust-worthy	Very untrust-worthy	I didn't use this source
My local fire department	○	○	○	○	○	○
U.S. Forest Service	○	○	○	○	○	○
Internet searches	○	○	○	○	○	○
Inciweb	○	○	○	○	○	○
My neighbors	○	○	○	○	○	○
Media (e.g. newspapers, TV news, radio)	○	○	○	○	○	○
The City of Flagstaff	○	○	○	○	○	○
Law enforcement (e.g. Sheriff's Office)	○	○	○	○	○	○
Coconino County	○	○	○	○	○	○
My family and friends	○	○	○	○	○	○
Neighborhood groups (e.g. Homeowners Association)	○	○	○	○	○	○
Social groups (e.g. recreation clubs)	○	○	○	○	○	○
Other: _____	○	○	○	○	○	○

Q2. Are you signed up for the Coconino County emergency alert system? *Mark one answer.*

- ○ Yes
- ○ No
- ○ I don't know

Q3. How do you expect to be notified about a wildfire or flood event that threatens your Flagstaff home? *Please mark all that apply.*

- ○ By my neighbors or family members
- ○ Local news outlet (e.g. newspaper or TV)
- ○ An in-person visit from a local official
- ○ The Coconino County emergency alert system
- ○ City of Flagstaff government
- ○ Social media (e.g. Facebook, Twitter)
- ○ Other (please explain) _____

Q4. Which social media platform(s) do you use to find local emergency information? *Please mark all that apply.*

- ○ Facebook
- ○ Twitter
- ○ Online community forum (e.g. Nextdoor)
- ○ Other (please list) _____
- ○ None/I do not use social media

Q5. Please indicate the extent to which you agree or disagree with the following statements about communication during the Museum Fire and subsequent post-fire flood risk. *Please mark one answer for each statement.*

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
Communication about the Museum Fire and post-fire flood risk was clear	○	○	○	○	○
Enough information was available for me to make decisions about the safety of my household	○	○	○	○	○
It was easy to find answers to questions I had about the Museum Fire and/or post-fire flooding	○	○	○	○	○

Section 3: Evacuation in Coconino County

Coconino County uses a three-level system called "***Ready, Set, Go!***" to communicate with residents about wildfire evacuation recommendations. Warnings during each of these three stages reflect the following:

Ready: Those at risk are made aware of the risk, but do not have to leave.

Set: Those at risk should be prepared to leave immediately.

Go: Immediate evacuation from the area is highly recommended. Roads will be closed to high risk areas, and residents deciding to stay may not receive assistance from emergency services.

The following questions ask you about the *Ready, Set, Go!* evacuation system.

Q1. Please mark to the extent to which you agree or disagree with the following statements about the *Ready, Set, Go!* evacuation system. *Please mark one answer for each statement.*

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
People expect to be notified by professionals about when to evacuate	○	○	○	○	○
The *Ready, Set, Go!* warning system for evacuation is clear	○	○	○	○	○
The *Ready, Set, Go!* warning system is the best way to ensure the safety of residents in my community	○	○	○	○	○
The *Ready, Set, Go!* warning system will not affect my plans during a wildfire	○	○	○	○	○
Residents only need to evacuate if they are contacted as part of the *Ready, Set, Go!* warning system	○	○	○	○	○
All three levels of the *Ready, Set, Go!* warning system will occur during wildfires	○	○	○	○	○
I know how I would be contacted about evacuation using the *Ready, Set, Go!* system	○	○	○	○	○

Q2. Was your Flagstaff home placed under evacuation using the *Ready, Set, Go!* system during the Museum Fire? *Please mark all that apply.*

- ○ No
- ○ Yes →
  - ○ My home was at the "**Ready**" level
  - ○ My home was at the "**Set**" level
  - ○ My home was at the "**Go**" level

Q3. Have you ever been evacuated from your home during a wildfire prior to the Museum Fire? *This could be any home you have lived in in the past. Please mark one answer.*

- ○ Yes
- ○ No
- ○ I'm not sure

Section 4: Forest management in the Flagstaff area

The following questions ask for your opinions about forest management in and around the City of Flagstaff.

Q1. Please indicate how important or unimportant it is to protect the following values from potential wildfire impacts in the Flagstaff area. *Please mark one answer for each statement.*

	Very unimportant	Moderately unimportant	Neither important nor unimportant	Moderately important	Very important
Watershed health and water quality	○	○	○	○	○
Forest health	○	○	○	○	○
Recreation opportunities	○	○	○	○	○
Local wildlife	○	○	○	○	○
Air quality	○	○	○	○	○
Scenic views	○	○	○	○	○
Commercial timber	○	○	○	○	○
Tourism revenue	○	○	○	○	○
Local businesses	○	○	○	○	○
Safety of life and property	○	○	○	○	○

Q2. Please indicate the extent to which you agree or disagree with the following statements about forest management around Flagstaff. *Please mark one answer for each statement.*

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
Forest management has decreased the likelihood of a **wildfire** impacting my home	○	○	○	○	○
Forest management has decreased the likelihood of a **flood** impacting my home	○	○	○	○	○
I would like to see forest management accelerated around Flagstaff	○	○	○	○	○
Forest management should be a priority for Flagstaff officials	○	○	○	○	○
Wildfire risk to Flagstaff is mostly from **public** lands (e.g. National Forests, City or State lands)	○	○	○	○	○
Wildfire risk to Flagstaff is mostly from **private** lands	○	○	○	○	○
Forest management has negatively impacted recreation in the Flagstaff area	○	○	○	○	○

Please continue to the next page

Q3. Please indicate the extent to which you agree or disagree with the following statements about wildfire risk in the Flagstaff area. *Please mark one answer for each statement.*

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
Enough is being done to address fire risk on **public** lands around Flagstaff	○	○	○	○	○
Enough is being done to address fire risk on **private** lands around Flagstaff	○	○	○	○	○
I could do more to reduce wildfire risk to my Flagstaff home	○	○	○	○	○
Responsibility for protecting homes from wildfire lies primarily with the homeowner	○	○	○	○	○
Property owners should be required by law to manage fire-prone vegetation around their home	○	○	○	○	○

Q4. Please indicate how acceptable or unacceptable you find the following strategies for financing forest management to reduce wildfire risk in the Flagstaff area. *Please mark one answer for each statement.*

	Very unacceptable	Moderately unacceptable	Neutral	Moderately acceptable	Very acceptable
Increased city taxes	○	○	○	○	○
Increased property tax	○	○	○	○	○
Increased fees for household utilities	○	○	○	○	○
No additional fees for forest management	○	○	○	○	○
Other_____	○	○	○	○	○

Q5. Please indicate below how much you would be willing to pay a month to support wildfire risk reduction in and around Flagstaff. *Please write a dollar amount in the box.*

$ _____ a month

Q6. Please indicate how acceptable or unacceptable you find the following forest management outcomes. *Please mark one answer for each statement.*

	Very unacceptable	Moderately unacceptable	Neutral	Moderately acceptable	Very acceptable
Smoke or reduced air quality	○	○	○	○	○
More open forests	○	○	○	○	○
Temporarily reduced recreation access to manage forests	○	○	○	○	○
Prescribed fire	○	○	○	○	○
Presence of residual materials removed during forest management	○	○	○	○	○
Temporary roads	○	○	○	○	○
Burned areas	○	○	○	○	○

Q7. Please indicate the extent to which you agree or disagree with the following statements about the Museum Fire. *Please mark one answer for each statement.*

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
Fire is a natural part of the landscape around Flagstaff	○	○	○	○	○
The landscape will recover from the impacts of the Museum Fire	○	○	○	○	○
The Museum Fire had a beneficial impact on the health of this landscape	○	○	○	○	○
The Museum Fire negatively impacted recreation opportunities	○	○	○	○	○

Q8. Please mark the extent to which you agree or disagree with the following statements about the Museum Fire. *Please mark one answer for each statement.*

	Strongly disagree	Moderately disagree	Neutral	Moderately agree	Strongly agree
Firefighting response to the Museum Fire was adequate	○	○	○	○	○
Flood risk after the Museum Fire was preventable	○	○	○	○	○
Efforts to address flood risk after the Museum Fire were adequate	○	○	○	○	○
The Museum Fire was not a typical fire for this area	○	○	○	○	○
The Museum Fire was preventable	○	○	○	○	○
Flagstaff was well prepared for an event like the Museum Fire	○	○	○	○	○

Section 5: Flagstaff Watershed Protection Project (FWPP)

City of Flagstaff residents had the opportunity to support the funding for the "Forest Health and Water Supply Protection Project" (Question 405) on the 2012 vote ballot. This municipal bond project would finance up to $10 million to support planning and implementation of forest health and water supply protection on U.S. Forest Service, State and City lands in the Flagstaff area. This effort later became known as the Flagstaff Watershed Protection Project (FWPP) after it was passed.

The following questions ask for your thoughts on the Flagstaff Watershed Protection Project.

Q1. Do you remember how you voted for Question 405, "Forest Health and Water Supply Protection Project" in 2012? *Please mark one answer.*

- ○ I voted in support
- ○ I voted in opposition
- ○ I don't remember
- ○ I did not vote
- ○ I did not live in the City of Flagstaff during the 2012 vote
- ○ I was not old enough to vote in 2012

Q2. Please indicate the extent to which you agree or disagree with the following statements. *Please mark one answer for each statement.*

	Strongly disagree	Moderately disagree	Neutral	Moderately agree	Strongly agree
Partnerships between the City, U.S. Forest Service, and other organizations are the best way to address fire risk to Flagstaff	○	○	○	○	○
More money should be invested in FWPP	○	○	○	○	○
Efforts like FWPP mean that less action is needed to address fire risk on my private property	○	○	○	○	○
Forest management under FWPP has reduced the risk of wildfires in Flagstaff	○	○	○	○	○
Forest management under FWPP has reduced the risk of flooding in Flagstaff	○	○	○	○	○
I would support future initiatives like FWPP to reduce wildfire and flood risk in Flagstaff	○	○	○	○	○
All recent forest management around Flagstaff is tied to FWPP	○	○	○	○	○

Section 6: Museum Fire cause

Q1. Are you aware of the reported cause of the Museum Fire? *Please mark one answer.*

- ○ Yes
- ○ No

Please continue to the next page

Section 7: Background information

The following questions ask for some basic information about your household. All information provided in this survey will remain private and is not tied to you in any way.

Q1. Please mark whether you own or rent the property that this survey was sent to. *Please mark one answer.*

- ○ Own
- ○ Rent

Q2. Please mark which gender you identify as. *Please select one answer.*

- ○ Male
- ○ Female
- ○ Other

Q3. In what year were you born?

_____ YYYY (e.g. 1978)

Q4. Are you currently a student in higher education? (e.g. at NAU, Coconino College). *Please mark one answer.*

- ○ Yes
- ○ No

Q5. Are you or have you ever been employed by an industry or organization associated with the following? *Mark all that apply.*

- ○ Forestry or wood products
- ○ Firefighting or fire management
- ○ Public safety, law enforcement or emergency management
- ○ Insurance or real estate
- ○ Recreation and tourism
- ○ Water or water management
- ○ I have never been employed in any of these industries

Q6. Approximately how many years have you lived in Flagstaff?

_____ (e.g. *15*)

Q7. Please indicate the highest level of education that you have completed. *Please choose one.*

- ○ Elementary school
- ○ High school diploma or GED
- ○ Associate's degree
- ○ Technical or trade school
- ○ Bachelor's degree or other four-year degree
- ○ Master's degree
- ○ Professional degree (e.g. MD, DSS, DVM, JD)
- ○ Doctorate degree (e.g. Ph.D., EdD)

Q8. Please indicate your race/ethnicity below. *Select all that apply.*

- ○ American Indian or Alaskan Native
- ○ Asian
- ○ Black or African-American
- ○ Hispanic or Latino
- ○ Native Hawaiian or other Pacific Islander
- ○ White/Caucasian
- ○ Other

Q9. Which of the following best describes the total annual income of this household before taxes? *If you are retired, please indicate the amount of money you receive from your annual retirement benefits. Please mark one answer.*

- ○ Less than $20,000 per year
- ○ $20,000 to 39,999 per year
- ○ $40,000 to $59,999 per year
- ○ $60,000 to $79,999 per year
- ○ $80,000 to $99,999 per year
- ○ $100,000 to $149,999 per year
- ○ $150,000 to $199,999 per year
- ○ $200,000 to $249,999 per year
- ○ $250,000 or more per year

Q10. To better understand resident experiences with the Museum Fire, we may be interested in inviting you to provide your thoughts in additional studies. If you would be willing to participate in other future research efforts such as a one-on-one interview or group discussion, please provide your contact information below:

Email:

Phone:

Thank you for completing this survey. Your time and opinions are appreciated. If you have any additional thoughts about the Museum Fire or related topics, please share them below.

Fold booklet in half to fit in return envelope

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About the ERI White Paper Series: Issues in Forest Restoration

Ecological restoration is a practice that seeks to heal degraded ecosystems by reestablishing native species, structural characteristics, and ecological processes. The Society for Ecological Restoration International defines ecological restoration as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability … Restoration attempts to return an ecosystem to its historic trajectory" (Society for Ecological Restoration International 2004).

Throughout the dry forests of the western United States, most ponderosa pine forests have been degraded during the last 150 years. Many ponderosa pine areas are now dominated by dense thickets of small trees, and lack their once-diverse understory of grasses, sedges, and forbs. Forests in this condition are highly susceptible to damaging, stand-replacing fires and increased insect and disease epidemics. Restoration of these forests centers on reintroducing frequent, low-intensity surface fires—often after thinning dense stands—and reestablishing productive understory plant communities.

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of dry, frequent-fire forests in the Intermountain West. By allowing natural processes, such as fire, to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

The ERI Issues in Forest Restoration series provides overviews and policy recommendations derived from research and observations by the ERI and its partner organizations. While the ERI staff recognizes that every forest restoration is site specific, we feel that the information provided in the series may help decision-makers elsewhere.

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